Source Contribution in the Prince George Airshed using Sector Analysis

Prince George has a population of about 75,000 people and contains three pulp mills, an oil refinery, seven sawmills, a brewery, two major asphalt plants, as well as numerous smaller industries. The two major industrial sites located northeast and south of the city core, are both about the same elevation as the downtown. Most of Prince George in located in an area commonly defined as the “bowl” (Figure 1). The shape of the “bowl”, at the confluence of the Fraser and Nechako Rivers, contributes to periodic build-up of contaminants. Lower-level emissions are insufficiently buoyant to escape the valleys during periods of light winds and temperature inversions. Due to down slope flow at night, the lower-level emissions from the industrial site northeast of the bowl common flows into the community. Higher-level emissions can escape the valley but are trapped at night due to an inversion aloft. During calm winds these pollutants build up in this inversion layer and can be brought back to the surface late the next morning due to a process know as fumigation. Fumigation occurs when the nocturnal inversion aloft breaks down due to the air near the surface being heated and rising. This warm rising air is replaced by the cooler air aloft which brings the pollution trapped aloft back down to the surface. This occurs frequently in the Prince George airshed and is quite noticeably when a combination of pollutants increases in levels simultaneously late in the morning and remains high for several hours. The combination of the terrain and local meteorology plays a major role in the frequency and duration of episodes of exceedances of unacceptable air quality.

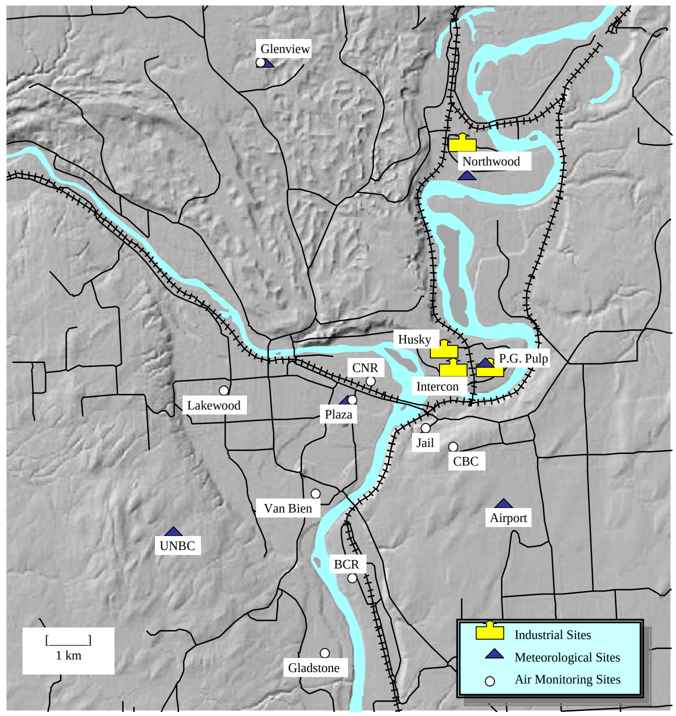
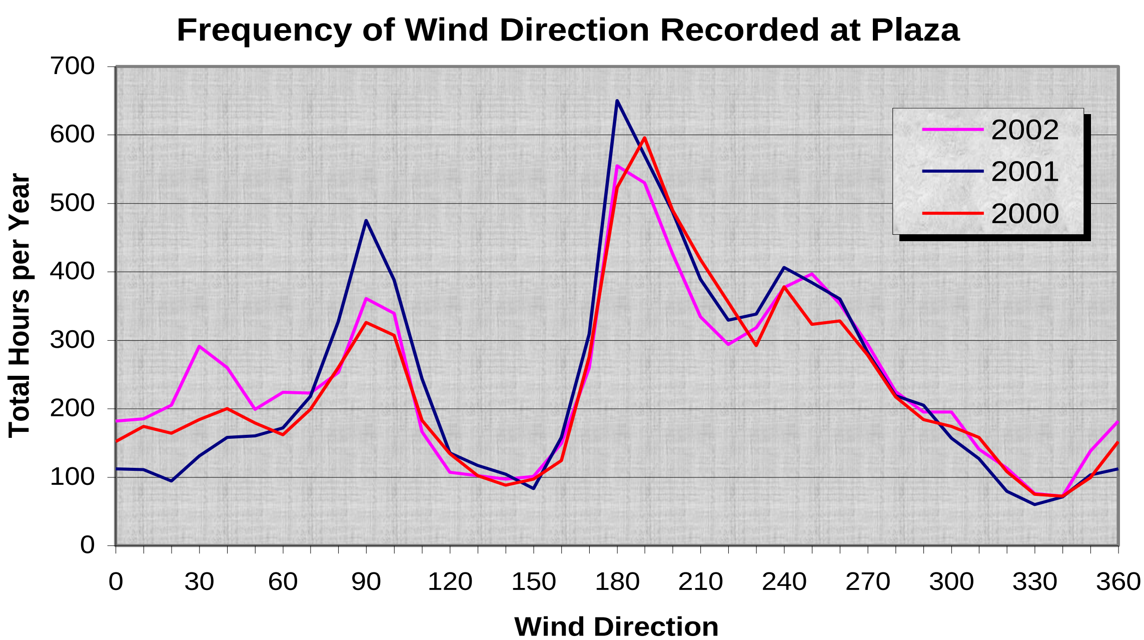


Figure 1: Map of Prince George

A combination of numerous industrial sources in the airshed and local area source such as rail, road dust and wood stoves surrounding a monitor makes it difficult to determine the contribution for a particular industrial source, or even the major sources contributing to the airshed. Another complicating factor is that the terrain influences the wind direct. Northerly winds blowing over the pulp mills can be deflected by the terrain located south of the mills causing winds to shift to east-southeast. Quite often SO2 and TRS levels are detected at the monitor during southeast winds even though the mills are located east-northeast from the monitor. Some techniques to determine a contribution are to use numerous monitors surrounding an area or to use speciation monitors. Both methods can be expensive and still only provide an estimate. One other approach uses the monitors located in the downtown area to estimate contributions not from each source but from each location in which major sources are located. The object of this paper is to determine how much pollution the pull mills contribute to the downtown location in relation to other combine sources.

Contribution at a monitor from a source depends on the amount of pollution being emitted from that source and the frequency the winds are blowing towards the monitor from that source. Two identical sources emitting the same amount of pollutants and at equal distance from a monitor will have different contributions to an air shed depending on the location. A source located southwest of a monitor may contribute five times more pollution to the air shed than a source located southeast of the monitor solely due to the prevailing winds from the southwest being five times more frequent than those from the southeast. Figure 1 shows the number of hours winds were blowing from each sector for each of the three years in the study period. Notice winds blowing from 180 degrees occurred about six times more frequent than those blowing from 140 degrees. The reduced frequency of winds blowing from 220 degrees could be due to the influence from Connaught Hill located just southwest of the meteorological site. Winds blowing from 220 degrees could be deflected around this hill causing them to shift to 180 or 240 degrees by the time they reach the meteorological instrument.

Figure 2



METHOD:

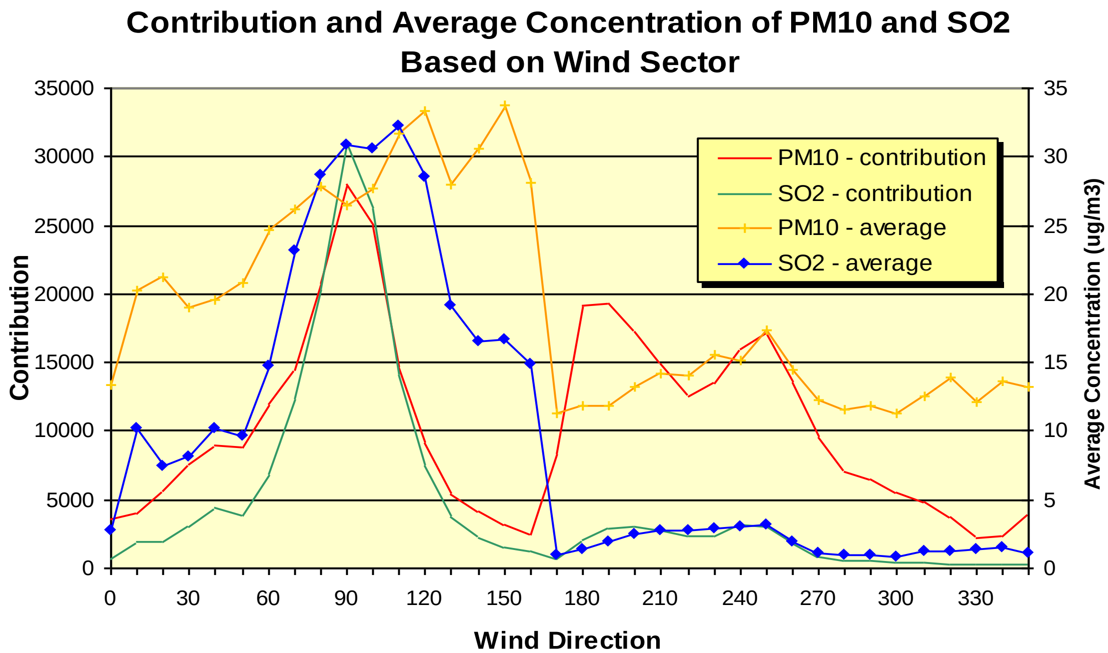
To determine the contribution from each source the area was first divided into 36 ten degree sectors using polar co-ordinates centered at the downtown monitoring station (e.g. the 30 degree sector covers all wind directions from 25-34 degrees). The contribution from each sector was calculated based on the average concentration from each sector times the number of hours the wind blew from this sector when the monitoring instrument was operating (Table 1).

Table 1

	Average Concentration			Hours Instrument Operated			Total Contribution		
Sector	NO	PM2.5	SO2	NO	PM2.5	SO2	NO	PM2.5	SO2
0	7.2	6.2	2.7	224	269	261	1218	1143	713
10	17.1	11.3	10.2	168	193	190	2581	1815	1929
20	16.4	11.6	7.5	223	260	250	3268	2506	1870
30	13.7	9.7	8.2	356	393	379	4279	3058	3099
40	14.8	10.5	10.2	385	455	425	5025	3877	4346
50	21.1	11.2	9.6	354	421	403	6849	3884	3860
60	25.9	13.9	14.7	416	486	464	10052	5812	6834
70	28.2	16.0	23.2	463	560	535	12273	7867	12413
80	32.0	16.9	28.6	633	744	713	19158	11138	20396
90	28.4	17.0	30.8	927	1050	1005	24755	15814	31001
100	23.0	17.7	30.6	772	902	856	16429	14254	26225
110	32.5	19.4	32.2	388	461	435	11923	8047	14008
120	28.5	20.2	28.6	228	271	259	6096	4960	7401
130	28.9	17.0	19.2	162	195	191	4405	2931	3669
140	35.5	18.1	16.5	115	137	135	3889	2220	2229
150	42.5	19.6	16.7	81	96	90	3302	1696	1500
160	30.8	17.9	14.9	78	87	83	2272	1392	1240
170	6.2	4.3	1.0	636	749	700	2845	1794	711
180	6.1	3.9	1.3	1327	1642	1559	5839	3267	2048
190	8.0	4.8	1.9	1289	1636	1530	8115	4771	2918
200	10.2	6.2	2.4	1067	1323	1249	9035	5672	3040
210	12.1	6.8	2.7	862	1057	999	8970	5151	2740
220	13.3	7.0	2.7	739	898	849	8558	4541	2306
230	16.7	7.3	2.9	741	877	828	11126	4745	2387
240	17.5	7.2	3.1	934	1067	1025	14746	5581	3145
250	22.4	8.1	3.1	849	1002	964	17539	6194	2998
260	21.9	6.5	1.9	783	951	917	15770	4329	1768
270	17.6	5.0	1.1	667	792	765	10593	2421	864
280	17.1	4.8	1.0	510	609	583	7824	1719	570
290	14.1	5.3	1.0	476	554	533	5895	1840	541
300	11.9	5.2	0.9	407	493	457	4153	1600	391
310	11.1	5.6	1.2	333	400	368	3127	1485	440
320	14.9	6.4	1.2	219	270	259	2885	1219	316
330	11.3	5.5	1.3	153	178	169	1467	631	228
340	10.0	6.5	1.5	143	178	171	1191	805	259
350	8.0	6.0	1.1	255	300	280	1607	1218	307

Figure 3 shows the difference in average concentrations for every sector compared to the contribution for each sector for PM10 and SO2. The average concentration for PM10 is fairly consistent between 170 degrees and 360 degrees. However, the PM10 contribution from the 190 degree sector is almost nine times the contribution from the 330 degree sector. Average concentration for SO2 at 90 degree sector is about twice the concentration from the 150 degree sector yet the contribution is over twenty times higher.

Figure 3



Before the contribution from each sector was calculated, data was first manually examined and certain hours were flagged as unknown, non-pulp, or pulp influence. The flagged unknown, non-pulp, and pulp influence data were removed from the main database for a separate analysis which will be discussed later in the report.

The remaining data was then broken down into the ten degree sectors. These ten degree sectors were then grouped into larger sectors (Figure 3). Because the three pulp mills are located north to east-northeast from the monitor, this sector is defined as the pulp mill industrial sector and it covers all wind directions blowing from the north (0^o) to southeast (160^o) sectors, with most of the higher levels coming from the northeast (50^o) to east (100^o) sector. In areas with complex terrain light winds are easily influenced by the terrain. In Prince George northerly winds recorded at the pulp mills are steered by the hills located south causing winds at the downtown monitoring site to be blowing from the east-southeast. Most of the highest SO_2/TRS levels are recorded at the downtown site during east-southeast winds, even though the pulp mills are located east-northeast of the monitor. For the pulp mills sector it is recognised that not all SO_2/TRS is emitted from the pulp mills. Husky refinery is located in the same general area and may be contributing to the SO_2/TRS levels. However, it is not possible to determine exactly what percent is coming from the refinery. On the other hand, very little particulates are emitted from the refinery; hence one can assume most of the particulates are coming from the pulp mills or from low levels area

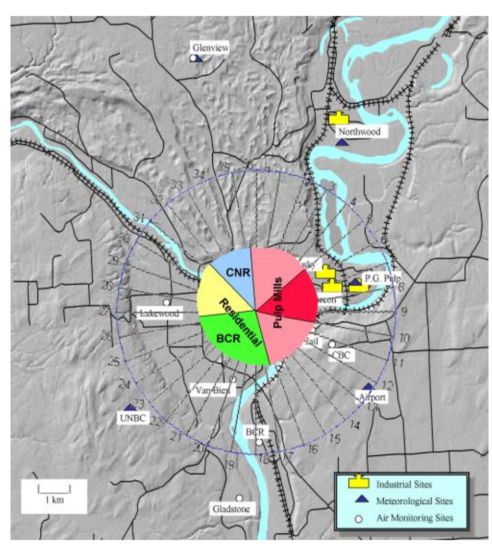


Figure 3: Sector breakdown

sources located between the pulp mills and the monitor. The residential area covers all sectors from south (170^o) to northwest (310^o). The BCR industrial site is included as a portion of the residential sector and ranges from south (170^o) to west (260^o). The CNR commercial area ranges from northwest (320^o) to north (350^o) sectors.

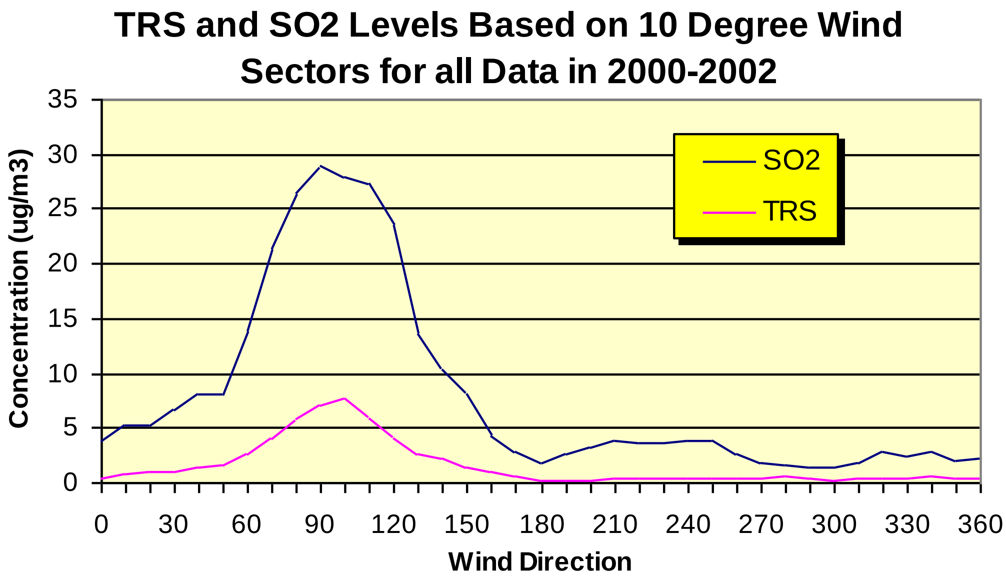
The “Unknown” source represents hours in which it was not possible to determine a main source. This included the hours when meteorological data was not available for that site and it was not possible to determine a general wind direct when examining other nearby meteorological data. The unknown data also included winds that were light and had no persistent direction for several hours.

Quite frequently in Prince George pollutants from the pulp mills would build up in the airshed mainly due to periods of light down slope flow. Winds may shift and increase in speed but, depending on the wind speed or the duration of the build-up of pollutants, it may take several hours for the pollutants to flush out of the airshed. This was taken into consideration when examining the data and even though winds were blowing from one sector the pollution levels during that hour may be included in a different category. If either SO2 or TRS was detected at the downtown monitor when winds were blowing from the pulp mill sector and the following hour winds shifted to another direction outside the pulp mill sector and both SO2 and TRS was still being detected, then that hour and possibly the follow hour (depending on SO2/TRS levels and wind direction) was classified as “pulp mill influence” and included with the “pulp mill” sector. This was considered only for occasions when winds shifted from the pulp mill sector to another sector and that period was not already classified as “unknown”.

The time a plume reaches a monitor depends upon the wind speed. Winds may shift from one sector to another sector but it may take an hour or two (depending on wind speed and distance between the source and the monitor) before the monitor starts to detect the influence from the main sources in that sector. In determining the influence from the pulp mills, hours were classified as “non-pulp” sources if the wind direction shifted to flow from the pulp mill sector and no SO2 or TRS levels were yet detected by the monitor. This was considered only when winds shifted to the pulp mill sector and that period was not already classified as “unknown”. No attempt was made as to what other sectors these hours should be included with.

Even though the main pulp mills sources are located about east-northeast (70 degrees) from the monitoring site, levels have been detected from zero degrees (mainly due to Northwood Pulp located north-northeast) to 170 degrees and the maximum concentrations occurred around 80-100 degrees. As previously mentioned the terrain located south from the pulp mills re-directs the pulp mill plume towards the monitor. The lighter winds are more easily affected by the terrain and even if winds are blowing from the north at the pulp mill, they a commonly east at the monitoring site. Maximum SO2 concentrations tend to occur with winds blowing from about 90 degrees and average concentrations decreasing as the wind direction shifted away from 90 degrees. Approaching near zero as the wind direction reached 0 degrees and 170 degrees or outside this sector (Figure 3).

Figure 4



Analysis of the winds blowing from the pulp mill sector showed that during times with strong winds the wind direction may be less influenced by the terrain. In that strong winds blowing from the southeast were in fact southeasterly winds rather than northerly winds being deflected by the hillside located south of the monitor site. The speed at which winds increased so that no SO2 or TRS was detected at the downtown monitoring station depended upon the wind direction. Analysis of the 2000-2002 data showed that the wind speed cut off in which no SO2/TRS was detected decreased as the wind direction shifted away from the pulp mill sources. The wind direction and speeds when the pulp mill sources may affect the monitor are shown as shaded areas in Table 2. The hours in which the wind speed and direction were in the non-shaded area in the table were then classified as either non-pulp (0-50) or non-pulp (100-160), indicating that winds were blowing from those sectors but very little contribution from the pulp mills affected the monitor. These hours were added to the non-pulp category. Because levels at those times were low, the removal of those hours resulted in very little change in the contribution to the airshed from the pulp mill sector. Also, because of other meteorological factors like stability, winds may be lighter than the cut-off chosen and still have no contribution from the pulp mills. Since this method did not change the results that much, reducing the cut-off speed may result in very little additional change. However if the cut-off speeds were lowered, it may result in an under-estimate in the pulp mill contribution. Reducing the cut-off speed would result in an increase in the number of hours of detectable SO2/TRS being eliminated from the pulp mill industrial sector (as the wind speed decreases for each sector the number of hours of detectable SO2/TRS increases).

Table 2
Wind Speed and Direction in Which SO2 or TRS is Detectable at Plaza

WD	WS	<1.7	1.7-2.0	2.0-2.5	2.5-3.0	3.0-3.5	3.5-4.0	.0-4.5	4.5-5.0	5.0-5.5	>5.5
0-4											
5-14											
15-24											
25-34											
35-44											
45-54											
55-64											
65-74											
75-84											
85-94											
95-104											
105-114											
115-124											
125-134											
135-144											
145-154											
155-164											
>165											

There were several occasions when winds were brisk and blowing from the 0-50 sectors in which SO2 was detected at the monitor but all other pollutants were low. During those hours this SO2 may have originated from a gas flare at the refinery rather than the pulp mills, since very little particulates or NO are emitted from the flare.

The “Background” source is difficult to calculate since this background can vary annually, seasonally as well as daily. Forest fires in the area can cause the background levels to increase dramatically, whereas, periods after a rainfall may have zero background levels. The best approach is to measure pollutants levels in a remote location and use those values as background. Unfortunately, no background monitoring data was available for the Prince George area. For lower wind speeds, pollutants may build up in the airshed and it was not possible to determine a background level. Background levels were calculated using sector averaging only for wind speeds above 3.0 m/s. Hours of data available decreased as the wind speed increase. Beyond 3.0 m/s the number of hours per ten degree sector decreased such that one abnormally high level may drastically affect the overall average for that sector. The stronger the wind the more mixing that normally occurs which means more contribution from background sources. As shown in Figure 5 the average concentration for $PM_{2.5}$ in any sector decreases as the wind speed increases. The concentrations in the sectors with the lowest average concentrations are similar whether all winds greater than 3 m/s were used or whether all winds greater than 4 m/s were used. The lowest average for any 10^o sector was used as the background for that year. This assumes that levels from other sectors may have more influence by upwind sources in the airshed. Since Prince George is surrounded by forest and farmland in all directions, and the nearest major city is located about 800 km away, this gives good confidence in assuming the lowest concentration in a 10 degrees sector would be representative of a background concentration for the surrounding area.

Figure 5

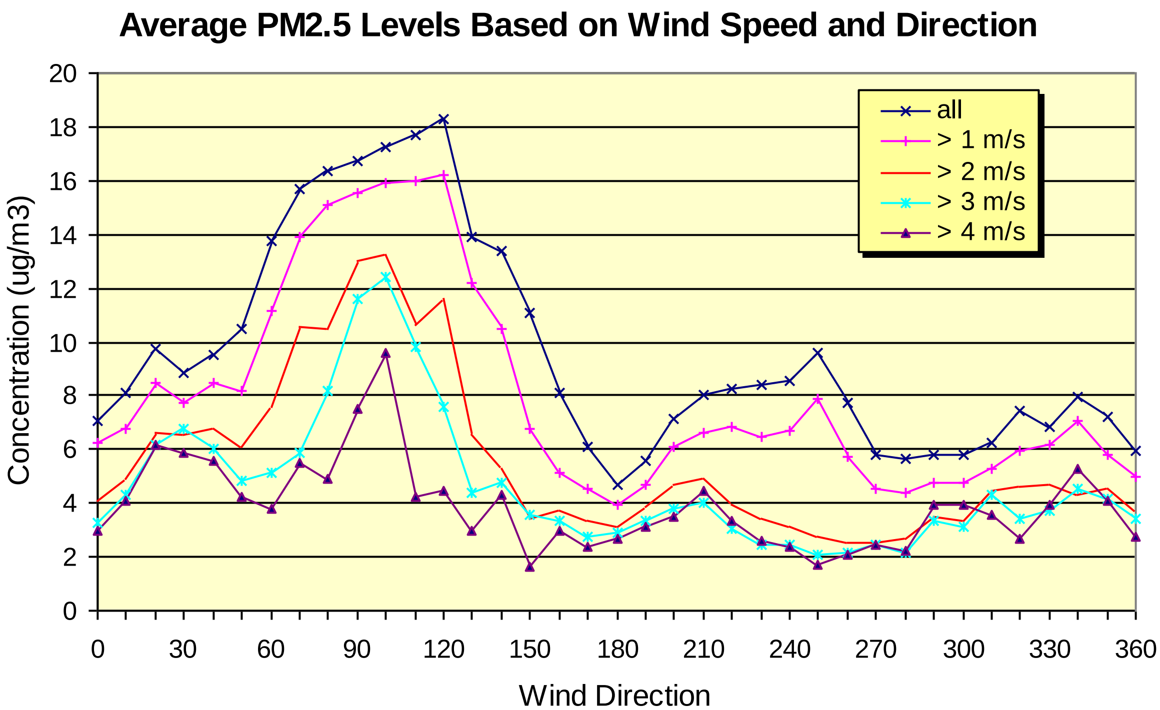


Table 3 shows the possible sectors and their representative wind direction (if applicable) that was used in this report. The Pulp Mill Industrial sector included three pulp mills, an oil refinery, a chemical plant and a portion of the CNR rail yard. The BCR site included several sawmills, a plywood plant, a cement plant and several commercial or small industrial sites. The CNR Commercial included mainly commercial operations, as well as the CNR rail yard and two sawmills.

Table 3

Major Sectors	**Wind Direction**
Pulp mill Industrial	0 – 160
BCR Industrial	170 – 260
Residence	170 – 310
CNR Commercial	320 - 350
Unknown	-
Background	-
Non-pulp	-
0-50	0-50 + WS
100-160	100-160 + WS

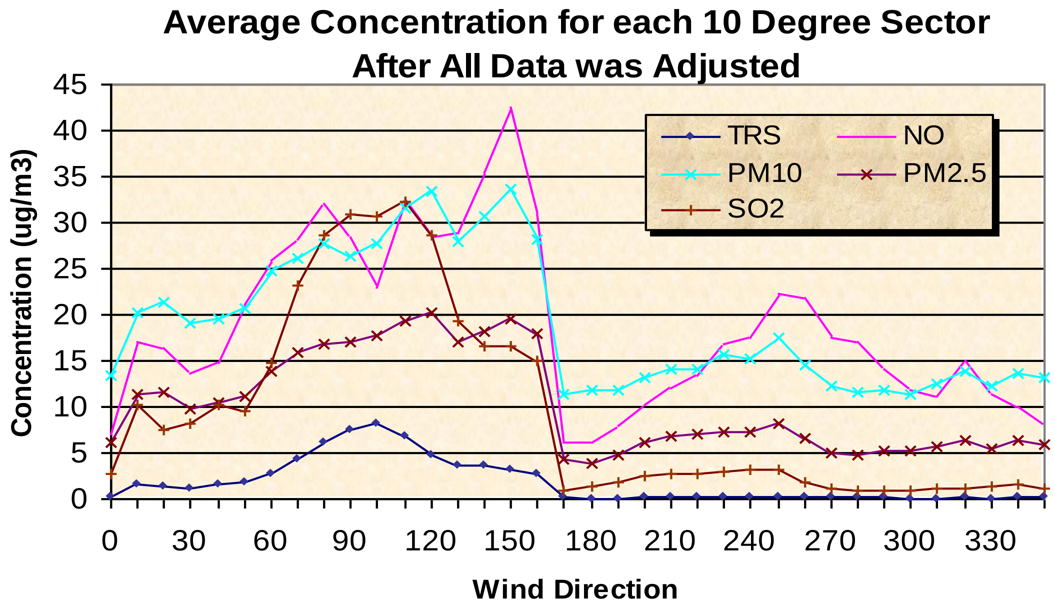
As shown in Table 1, the average concentrations per 10 degree sector for the edited database were calculated for SO_2, TRS, NO, PM_{10} and $PM_{2.5}$ at the downtown location. O_3 and NO_2 were not included in this report because they are mainly secondary pollutants and the amount of solar radiation can have a major influence on the results. Data for these two pollutants are available upon request. The actual concentration per 10 degree sector for each pollutant was calculated based on the average concentration for that sector minus the calculated background concentration for that pollutant. The contribution per 10 degree sector for each pollutant was then calculated based on the number of hours available per sector multiplied by the actual concentration per sector. To determine the contribution from the area of each major sector in Table 3 all 10 degree sectors from that area were added.

The same method was applied to the data that was removed from the edited database and put in the category of unknown, non-pulp or pulp influence. The actual concentrations for these three categories were also adjusted to remove the background concentration from the data. The contribution for each pollutant from each category was calculated by multiplying the actual concentration by the number of hours each pollutant was available. The contribution from the pulp influence category was added to the total contribution from the pulp mill industrial sector. In order to determine a contribution from the background sources the background average concentration for each pollutant was multiplied by the total number of available hours for each pollutant for that period. The percent contribution from each sector was calculated based on the ratio of the contribution from each sector to the total net contribution of all sources including background and unknown.

RESULTS

After all adjustments were made to the data it is now possible to determine which areas contribute the must to the downtown location in Prince George. Figure 6 shows that the highest PM10, PM2.5 and NO contributions are from the 60-160 degree sector, whereas SO2 and TRS are from the 80-120 sector, but elevated concentrations were detected from the 10-160 sector. The maximum contributions for all pollutants exist within the sector defined as the Pulp Mill Industrial sector.

Figure 6



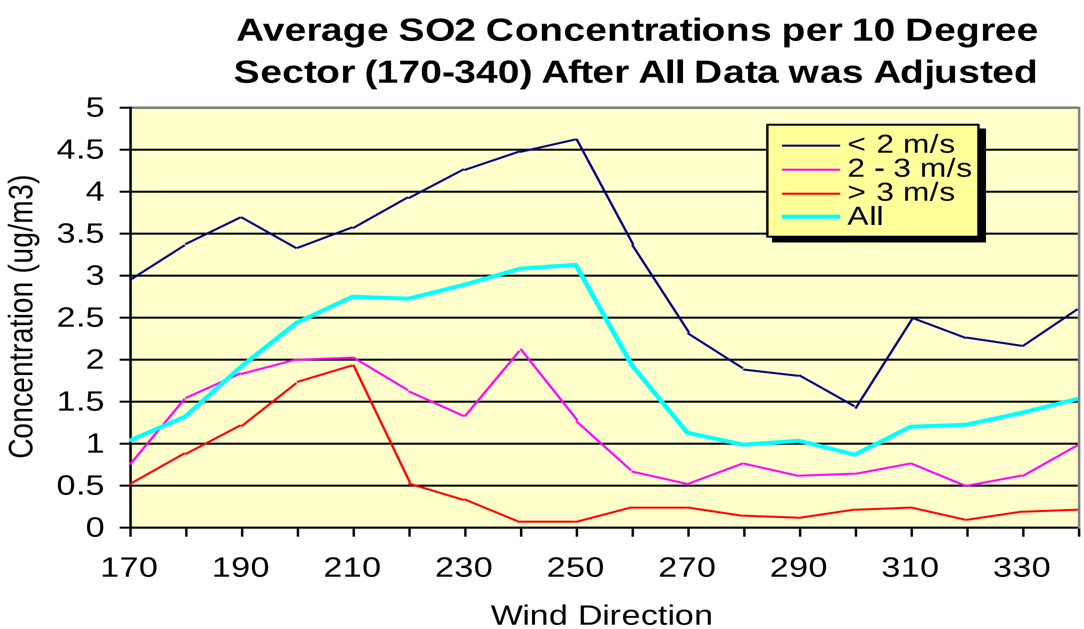
Using this method, it is possible to calculate the total SO2 contribution from the pulp mill industrial sector to be at least 77% (Table 4). The 9% from the BCR/residential sector is probable due to emission from a sulphuric acid plant located in the BCR industrial area. It is uncertain what portion of the unknown contribution would be contributed from the pull mill industrial sector. But an estimate will be made later in the report. As for TRS, about 83% was estimated from the pulp mill industrial sector and about 10% unknown. Even though there was about 44% of the PM2.5 calculated from the pulp mill industrial sector, only about 32% of the PM10 was estimated from that sector. Whereas, 21% of PM2.5 was contributed from background sources and almost 40% for PM10. These could be due to most of the particulates emitted from that sector are 2.5 um or less and due to the background contribution having a high portion from road dust which contains mainly coarser particles (> 2.5 um).

Table 4: Estimated Contribution to the Downtown Location

Sector	**SO2**	**PM2.5**	**PM10**	**TRS**	**NO**
Pulp mill industrial	77.2%	43.3%	31.4%	82.9%	39.7%
Residential	4.3%	7.8%	6.7%	1.9%	11.2%
BCR Ind/residential	9.2%	14.9%	11.5%	2.8%	19.9%
CNR Commercial	0.6%	1.6%	1.2%	0.3%	1.7%
unknown	7.2%	8.4%	6.7%	10.3%	15.5%
background	0.0%	20.6%	39.6%	0.9%	8.6%
non-pulp	0.9%	2.6%	2.0%	0.7%	3.4%
0-50	0.5%	0.7%	0.7%	0.1%	0.1%
100-160	0.1%	0.3%	0.2%	0.2%	<0.1%

The BCR Ind/Residential can be further broken into BCR Industrial and Residential contributions. As previously discussed, the light winds tend to be more influenced by terrain. Figure 7 shows the average SO2 concentration for all wind directions outside the pulp mill sector. Average SO2 levels between 180 to 270 degrees is much higher those between 270-340 degrees. The additional increase in levels may be associated with emissions from the sulphuric acid plant in the BCR Industrial site and is a good marker showing the sector in which contributions from the BCR area can be expected. Similar patterns are noticeable for the PM10, PM2.5, TRS and NO. Even though the BCR area is located south of the downtown monitor, contribution from this sector can occur in the area extending from 180 degrees to 260 degrees. As shown in Figure 7 the contribution from the BCR area during brisk winds (> 3 m/s) occurred about 180-220 degrees (approximately where the BCR Industrial area is located). For lights winds (< 2 m/s) the highest averages occurred at about 240-260 degrees. For winds between 2-3 m/s there were two peaks, one at 210 degrees and the other at 240 degrees. This may be due to winds being redirected around Connaught Hill which is located about 200 metres south-southwest from the monitor. It was assumed that the number of residents and the activities in these residential areas were about the same per 10 degree sector from 170 degrees to 300 degrees. Therefore, the average concentration from each of these 10 degree sectors would be almost same if the BCR Industrial site did not exist. In order to determine the contribution from just the BCR site the average concentration between 270-290 degree sector was subtracted from the average concentration in each of the 10 degree sectors that were classified as BCR Ind/Residential for each different wind speed category shown in Figure 7. The difference in concentrations was then multiplied by the number of hours from each sector to calculate the new contribution for only the BCR Industrial area. His approach was done for all pollutants monitored at the downtown location.

Figure 7



As a rough estimate as to what portion of the unknown category was contributed from each sector, the percent contribution for each sector minus the background was applied to the "unknown" category. The background contribution was removed from this calculation because that data was already removed from the "unknown" sources as well as all other sources. Over 90% of the unknown contributions for PM10 and PM2.5 were due to light and variable winds as well as over 98% of all SO2, TRS and NO contributions. Most of the remaining missing data that made up the "unknown" contribution were during periods of light winds recorded at other surrounding meteorological stations. Therefore, in this adjustment all unknown contributions were considered due to light winds. This would result in none of the "unknown" contribution was due to the non-pulp for 0-50 and 100-160 degree sectors. Table 5 shows the remaining sectors in which the "unknown" category may be a part of and the estimated percent of the "unknown" category that each sector may have contributed towards.

Table 5: Estimated Contribution of the "Unknown" Category at the Downtown Location

Sector	SO2	PM2.5	PM10	TRS	NO
Pulp mill Industrial	83.7%	61.7%	59.4%	93.6%	52.4%
Residential	7.0%	23.4%	21.7%	4.8%	38.8%
BCR Industrial	7.7%	8.8%	12.9%	0.4%	2.2%
CNR Commercial	0.6%	2.3%	2.3%	0.3%	2.2%
non-pulp	1.0%	3.7%	3.8%	0.8%	4.4%

Applying the ratios calculated in Table 5 to the amount of "unknown" contribution and adding this to the percent contribution in Table 4 gives an estimate of the overall contribution to the downtown location. Table 6 includes this adjustment as well as separating BCR Ind/Residential contribution to BCR Industrial and Residential contributions.

Table 6: Estimated Contribution to the Downtown Location
Separating BCR Industrial from Residential and Estimating the Unknown Distribution

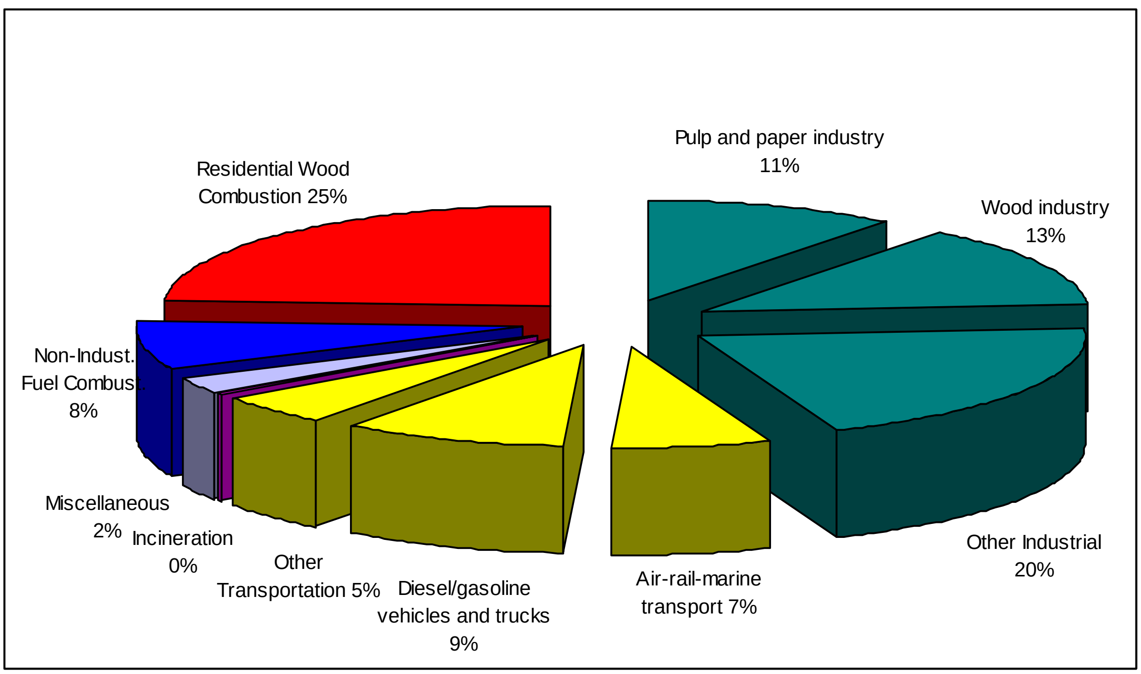
Sector	SO2	PM2.5	PM10	TRS	NO
Pulp mill Industrial	83.3%	48.5%	35.3%	92.5%	47.8%
Residential	6.9%	18.4%	12.9%	4.8%	35.4%
BCR Industrial	7.7%	6.9%	7.7%	0.4%	2.0%
CNR Commercial	0.6%	1.8%	1.4%	0.3%	2.0%
background	0.0%	20.6%	39.6%	0.9%	8.6%
non-pulp	1.6%	3.8%	3.1%	1.1%	4.2%

The calculated contribution to the airshed was compared with the predicted 2001 emission inventory. To determine the contribution from the combined industrial sources, the contribution from the pulp mill industrial, BCR industrial and CNR commercial sectors were combined. Background contribution was removed from the database. The percent contribution was then the ratio of the industrial contribution to the remaining contribution minus the background. This would result in a 91.5% contribution for SO2 from the industrial sectors compared to 88% estimated in for the 2001 emission inventory. For PM10 this would result in a 73.5% contribution compared to 75% estimated in for the 2001 emission inventory. The NO contribution showed the biggest difference with a calculated contribution of 56.7% compared to 31%. This difference may be due to the high NO emission estimated for rail being placed in the vehicle emission category in the emission inventory rather than the industrial emissions. It should be noted that the emission inventory only considers stack emissions and does not consider fugitive emissions or low levels emissions such as road dust which is included in the sector analysis.

Average PM10 and PM2.5 concentrations in Prince George for 2000-2002 were 18.1 and 9.4 ug/m3, respectively. The estimated PM2.5 background was 9.4 x 20.6% = 1.94 ug/m3 and for PM10 it was 18.1 x 38.7% = 7.17 ug/m3. Comparing this to data recorded at High Tower, Alberta which is a monitoring site designed to measure background concentrations, the PM2.5 background concentration is 2.1 ug/m3 (for May 2000 to December 2002) and for PM10 it was 5.7 ug/m3 (for Jan. 2000 to December 2002). This shows that the calculated background approach used in this paper provides a good estimate of the background concentration in the area.

As shown in Figure 7, Environment Canada estimated that the percent of PM2.5 emitting in Canada from pulp mill sources was 11%. There are three pulp mills in Prince George which has a population of about 70,000 compare to about 130 pulp mills in the rest of Canada which has a population of about 31,500,000. Considering the ratio of the number of pulp mills in the Prince George airshed with that for all of Canada the calculated 48% value for Prince George may be under estimated.

Figure 7
PM2.5 Emissions for Canada (excluding open sources)



Another approach in determining contribution of a particular pollutant is to use principal component analysis (also called Factor Analysis) which can be used as a data reduction technique or a method to separate ‘signal’ and ‘noise’. Principal component analysis was used to determine the degree to which PM2.5 (between 1998 and 2000) is related to the other ambient measures (NOx, SO2, TRS, coarse), where the coarse fraction is calculated as the difference between PM10 and PM2.5. Principal component analysis of ambient data from Prince George revealed 3 statistically significant factors (eigenvalues>0.7) that accounted for ~86% of the total variance in the dataset from 1998 to 2000. With respect to $PM_{2.5}$, ~51% of the variance was associated with events dominated by SO_2 and TRS, while secondary contributions associated with coarse sediment and NO_x accounted for 9% and 23% of the total PM2.5 variance respectively. Approximately 17% of the total PM2.5 variance remains unexplained. Since most of the SO2/TRS was from the Pulp Mill Industrial sector it could be assumed that most of this 51% of the variance would be from this sector. This is similar to the 48.5% contribution calculated in this report from that sector.

CONCLUSION:

The monitors at the downtown location are located on top of a five story building. Therefore, the results are representative of the general downtown air shed and even though areas located closer to the main traffic will have a difference contribution it is felt that it will be due to the addition of pollutants from vehicles or nearby sources which will result in much higher concentrations near the roads. The contribution will vary in other locations in the Prince George area depending on the distance and direction the area is from different sources.

Sector analysis method used in this report is just one tool in determining the contribution to the Prince George airshed. Even though this approach does not give an exact estimate of the contribution to the downtown area in Prince George it does show that the biggest contribution is from the pulp mill industrial sector. Particulate speciation monitoring as well as receptor modelling can help confirm whether these results are accurate. Similar results in the Principal Component analysis, emission inventories and the background levels at high Tower to that with the sector analysis approach gives confidence that this approach provides fairly accurate results.

REFERENCES:

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Chris Houser, E-mail contact.

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